Project	**IEEE 802.16 Broadband Wireless Access Working Group** <http://ieee802.org/16>
Title	Enhanced Constellation Rearrangement for HARQ
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Re:	IEEE 802.16m-08/024, "Call for Comments and Contributions on Project 802.16m System Description Document (SDD)", On topic of "Hybrid ARQ (PHY aspects)"
Abstract	A new signal constellation rearrangement for HARQ method is presented in this contribution, which implements signal combination before demodulation and demodulate the combined signal with new constellation. It is proposed to for discussion and adoption in the IEEE 802.16m HARQ PHY section.
Purpose	For 802.16m discussion and adoption
Notice	
Release	
Patent Policy	

Enhanced Constellation Rearrangement for HARQ

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Summary

A new signal constellation rearrangement for HARQ method is presented in this contribution, where a symbol-combining mappings are used for retransmission and at the receiver, it implements the combination before modulation and demodulate the combined signal with new constellation. The new constellation has the large minimum constellation distance and less constellation points. The proposed method has shown performance gain over the conventional HARQ constellation rearrangement. This contribution would like to propose for adoption in SDD HARQ section for further investigation.

Proposed SDD Text

Insert the following text into Physical Layer clause (Chapter 11 in [IEEE 802.16m-08/003r3])

-----------------------------*Begin Proposed Text* --

11.x HARQ mode

11.x.x Constellation Rearrangement

A HARQ method with symbol-combining constellation rearrangement shall be used.

-----------------------------*End of Text Proposal* --

1. Introduction

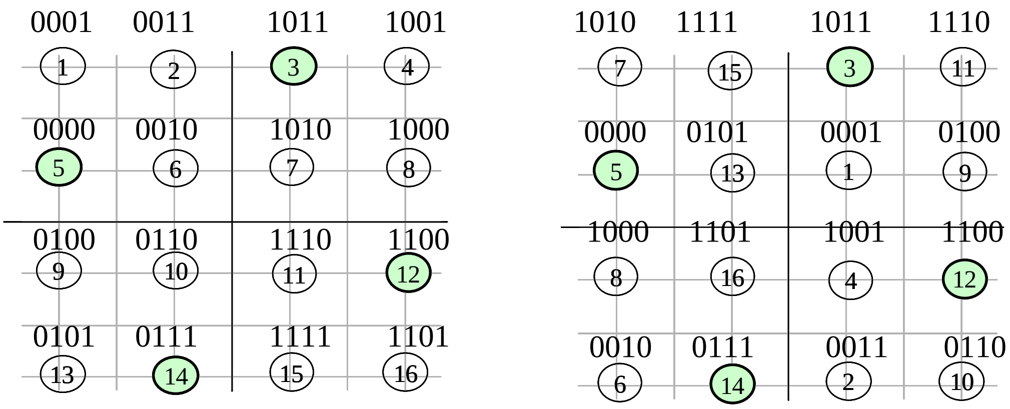
This contribution proposes a signal constellation rearrangement technique to enhance HARQ performance. The symbol-combining remappings are used for retransmission and receiver combines all the received symbols before demodulation to improve performance. The simulation results show that performance gain is achieved over the conventional remapping method.

2. Problem of Conventional Method

The inherent bit reliabilities are different for different bit positions in Gray labeling. To average out the un-even bit reliabilities, the less reliable bits are swapped with more reliable bits for retransmission in conventional method. The averaged bit reliability will enhance the HARQ performance over the Chase Combining. In conventional method, it implements the demodulation in each transmission separately and then it combines the reliability of each bit. It can't increase the minimum distance between 0 and 1 in each transmission.

3. Description of Proposed Method

For 16QAM, the mapping constellations for the first and the proposed remapping are shown in the following figure.



First transmission

Proposed mapping for 2nd transmission

Figure 3.1 Constellation rearrangement for 16 QAM

The illustration for the constellation remapping method is shown in figure 3.2. The blue circle is the mapped point in the first transmission, and the red circle is the mapped point in the second transmission.

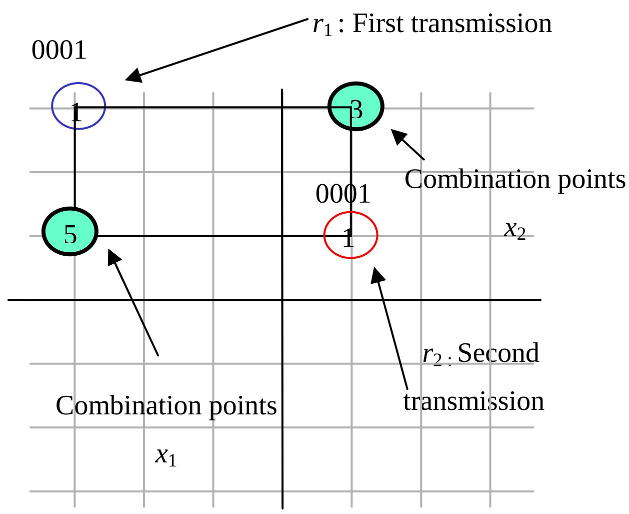


Figure 2.2 Illustration of constellation rearrangement for 16 QAM

Considering the AWGN channel, let r_1 be the received signal of first transmission and r_2 be the received signal of second transmission. At the receiver, the two signals are combined with the following method

$$x_1=\text{real}(r_1)+j*\text{imag}(r_2)$$

$$x_2 = \text{real}(r_2) + j*\text{imag}(r_1)$$

where real(a) and imag(a) represent the real part and imaginary part of a. The real part of the first transmission and the imaginary part of the second one are combined as a new symbol x_1 . The real part of the second transmission and the imaginary part of the first one are combined as a new symbol x_2. x_1 and x_2 are the green rounds and they are the symbols to be demodulated. The demodulation results of x_1 are the real part bits i_1 and i_2. The imaginary part bits q_1 and q_2 are the demodulation results of x_2.

$$i_1 i_2 = \text{demodulate}(x_1)$$

$$q_1 q_2 = \text{demodulate}(x_2)$$

With the ramapping constellation shown in figure 3.1, after the combination of the two received signal, all of the possible constellations for x_1 and x_2 are only four points, which is shown in figure 3.3. The minimum distance for the 4 points is large than conventional 16QAM.

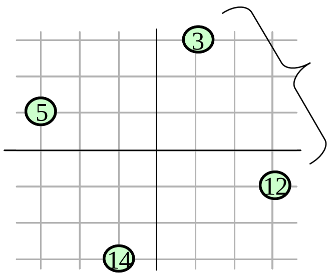


Figure 3.3 Constellation rearrangements for 64 QAM

The illustration for each constellation point is shown in Appendix.

4. Simulation Results

This section evaluates the error rate performance for both retransmission methods—the proposed constellation rearrangement vs. the conventional constellation rearrangement. The simulation environment is AWGN channel. Log-MAP algorithm with 8 iterations is performed in our simulation. The following table shows the simulation parameters including packet size, modulation and code rate.

Xx	**Information bits per packet**	**Turbo code rate**	**Number of transmission**
16-QAM	200	1/2	2

Figure 4.1 show that the proposed strategy has a gain over convention of about 0.2dB.

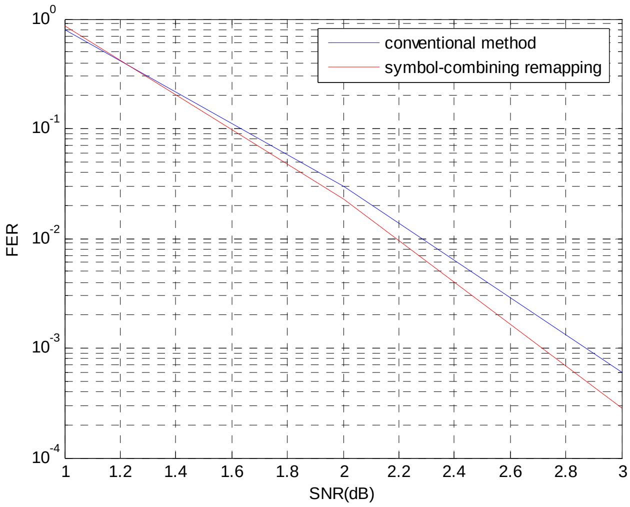


Figure 4.1 Performance comparison with 200bits per packet and 16QAM modulation.

5. Conclusions

In this contribution a new signal constellation rearrangement for HARQ method is presented. When transmitting repeated bits is required, this new method implements signal combination before demodulation and demodulate the combined signal with new constellation. The new constellation has the large minimum constellation distance and less constellation points. The proposed method has shown performance gain over the conventional schemes.

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References

[1] R1-01-0237, Panasonic, “enhanced HARQ method with signal constellation rearrangement” Las Vegas, USA February 27-March 2, 2001

Appendix

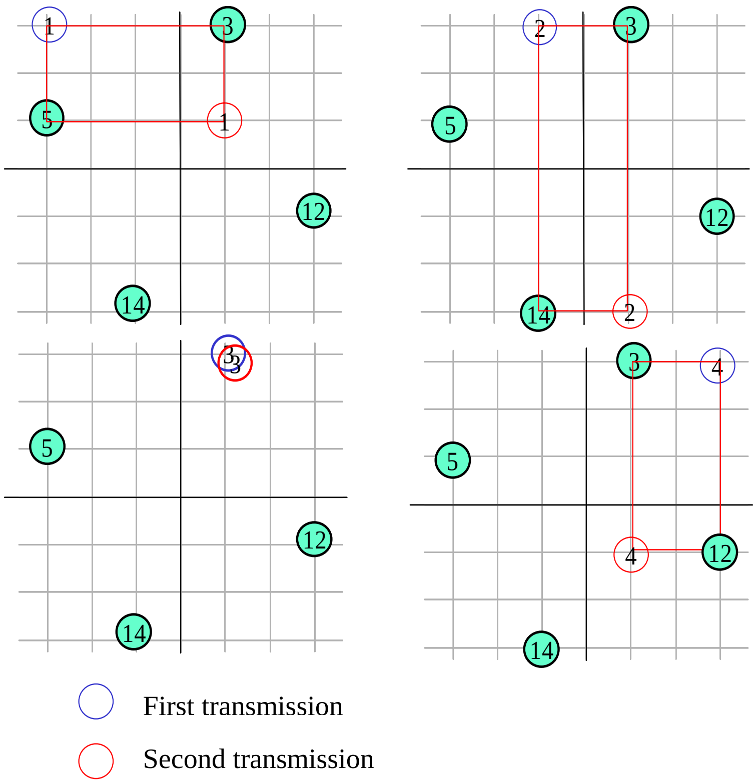

Figure A.1 Illustration of constellation rearrangement for 16 QAM.

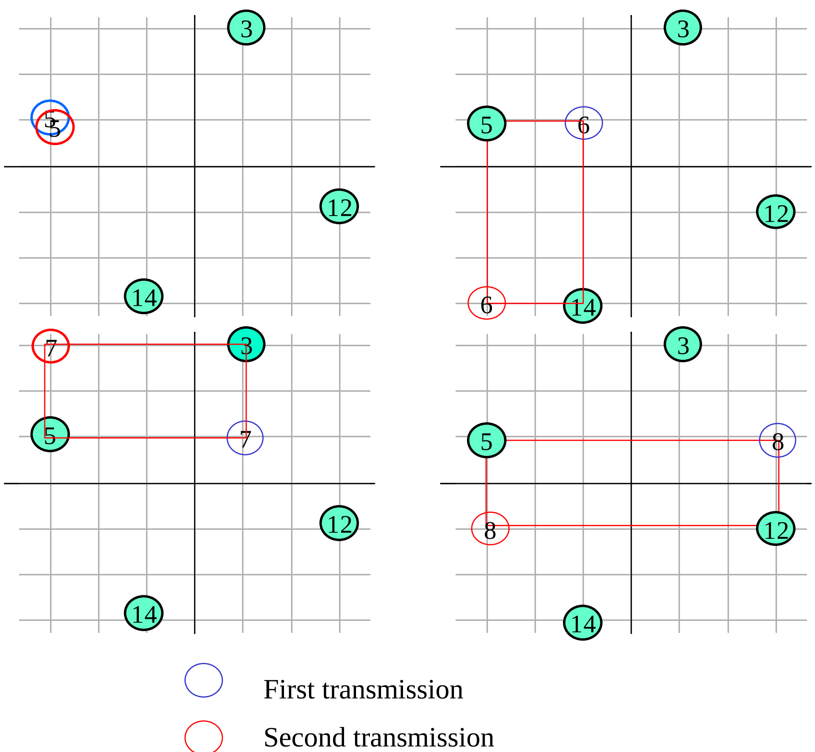

Figure A.2 Illustration of constellation rearrangement for 16 QAM.

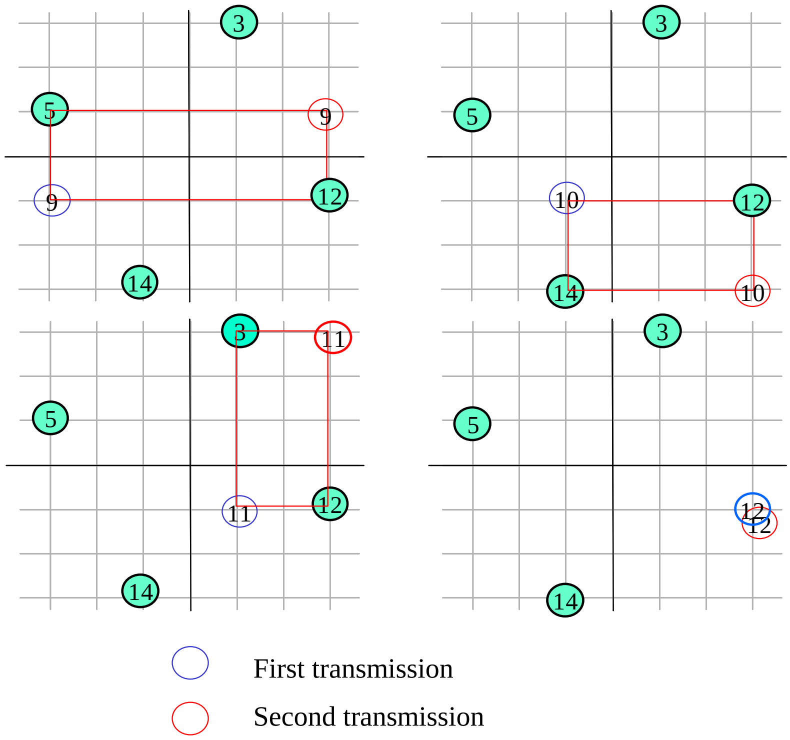

Figure A.3 Illustration of constellation rearrangement for 16 QAM.

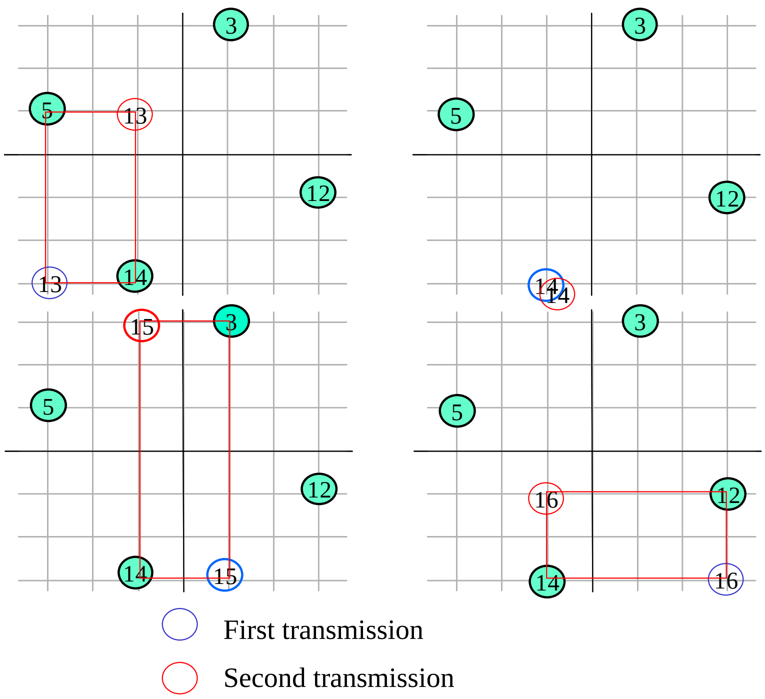

Figure A.4 Illustration of constellation rearrangement for 16 QAM.